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The Role of Subsequent License Renewal in Meeting U.S. Energy Policy and Climate Goals

Subsequent License Renewal Session – Part 1:
Addressing Tomorrow's Issues Today

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Delivering Clean Energy: Nuclear has to be part of the solution

2011

"By 2035, 80% of America's electricity will come from clean energy sources. Some folks want wind and solar, others want **nuclear**, clean coal, and natural gas. To meet this goal we will need them all."

President Barack Obama, 2011 State of the Union address

2014

"All-of-the above is not merely a slogan, but a clear-cut pathway to creating jobs and … reducing carbon emissions. President Obama has made clear that he sees **nuclear** energy as part of America's low carbon energy portfolio . . .

Energy Secretary Ernest Moniz, 2014 National Press Club speech

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Evolving Policy Drivers that support Clean Energy

- **Climate Action Plan – June 2013**
  - Reduce greenhouse gas emissions by 30% by 2030
- **Executive Order #13693 - March 19, 2015**
  - Reduce Federal facility greenhouse gas emissions 40% by 2025
  - Defines "clean energy" to include alternative energy
    - Definition of "alternative energy" includes "small modular nuclear reactor technologies"
- **Clean Power Plan – August 3, 2015**
  - Sets CO_2 emissions performance goals for every State in U.S.
  - Provides flexibility to States to choose how to meet carbon standards
    - Include renewables, energy efficiency, natural gas, **nuclear** and carbon capture and storage
- **COP21 – December 12, 2015**
  - International agreement to limit average temperature rise to <2°C
  - Reaffirmed U.S. commitment to carbon reduction goals

President Obama speaks at the Department of Energy on Mar 19, 2015

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Nuclear Power: A Sustainable Clean Power Source

"To meet our emissions reduction targets and avoid the worst effects of climate change, we need to dramatically reduce power sector emissions. Switching from coal to natural gas is already reducing the U.S. carbon footprint, but it's not enough to get the deep CO_2 cuts envisioned in the President's Climate Action Plan. Reducing emissions by 80% will likely require the complete decarbonization of the power sector….

We know nuclear can provide 24-hour baseload power, because it already does. Worldwide, nuclear power produces more energy than hydro, solar, wind, and geothermal power combined.

The bottom line is that to achieve the pace and scale of worldwide carbon reductions needed to avoid climate change, nuclear must play a role."

Secretary Moniz
COP21, Paris 2015

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Current Trends in Nuclear Power

- **There is widespread recognition of importance of nuclear – today and in the future – in meeting carbon reduction/climate goals**
- **Concerns about financial viability of some currently operating plants, yet these are needed to achieve large carbon reduction goals**
- **Increased interest in nuclear in domestic and international markets**
  - Gen III+
  - SMR technology
- **Innovators and "energy companies" are looking at advanced "Gen IV" nuclear as a way to move nuclear beyond electricity**

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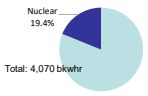
Nuclear Power Plays an Important Role in US Electricity Supply

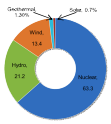
- **Nuclear power is a clean, reliable base load electricity source**
  - Provides ~19.4% of U.S. electricity generation mix
  - Provides ~63% of U.S. emission-free electricity
  - Avoids about 700 MMT CO_2 each year
  - Helps reduce overall NOx and SOx levels
- **U.S. electricity demand projected to increase ~24% by 2040 from 2013 levels**
- **Currently, 99 operating nuclear plants - 98 GWe of nuclear capacity**
  - In 2015, fleet generated 797.9 TWhr with an average capacity factor of 91.9% - 19.5% of U.S. electricity[1]
  - Most nuclear plants expected to obtain license renewal for 60 years of operation

Electricity Generation, 2013



Source: Energy Information Administration Annual Energy Outlook 2015

Low-carbon sources of electricity



1 - NEI January 2016 Announcement

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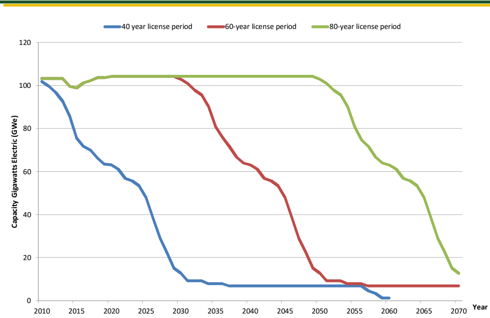
U.S. Nuclear Power Plants - Operation or Economic Shutdown

Light Water Reactor Sustainability (LWRS) Program

- **LWRS Program Goal**
  - Develop fundamental scientific basis to allow continued long-term safe operation of existing LWRs (beyond 60 years) and their long-term economic viability
- **LWRS program is developing technologies and other solutions to**
  - Justify long term operation
  - Improve reliability
  - Sustain safety
- **LWRS focus areas**
  - Materials Aging and Degradation
  - Advanced Instrumentation and Controls
  - Risk-Informed Safety Margin Characterization
  - Reactor Safety Technologies

Nine Mile Point
~ Courtesy Constellation Energy

Projected Capacity of Current Fleet



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Meeting Clean Energy Goals will Require a Shift in Electricity Production

Source	2013 Elect (TWhr)	2013 CO_2 (Gton)	2040 Elect (TWhr)	2040 CO_2 (Gton)
Natural Gas	1000	0.44	1569	0.51
Coal	1586	1.58	1695	1.66
Coal (CCS)	0	0	7	0
Nuclear (Large)	789	0	833	0
Nuclear (SMR)	0	0	0	0
Hydro	267	0	297	0
Renewable	262	0	612	0
Petroleum/Other	47	0.04	43	0.03
TOTAL	**3951**	**2.05**	**5056**	~~3.3~~ **1.0**

2013 U.S Electricity Consumption and CO_2 Emissions. ***EIA*** ***CE=33%***

EIA Reference Projections 2040
CE=36%

Source: EIA, Annual Energy Outlook 2015

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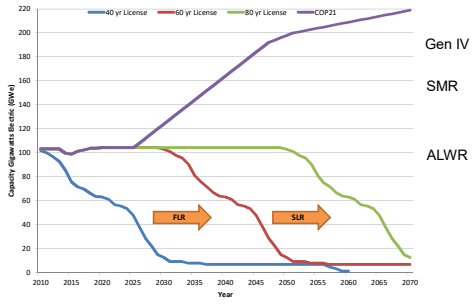
Nuclear Power Capacity needed to meet Clean Power Goals



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New Builds in U.S.

Will these be sufficient to overcome existing plant Retirements?

- **First new reactors being built in U.S. in 30 years**
- **Nuclear construction (Commercial Operation Date)**
  - Watts Bar 2016
  - Vogtle 2019 - 2020
  - V.C. Summer 2019 - 2020
- **Challenges of nuclear deployment**
  - High capital cost
  - Lower electricity demand
  - Low natural gas prices

Vogtle 3 & 4, Courtesy of Georgia Power

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Small Modular Reactors

SMR Licensing Technical Support (LTS) Program

- **Program initiated in FY12**
- **Mission: Accelerate U.S. deployment of SMRs by supporting certification and licensing through cost-shared cooperative agreements with industry partners**
- **Resolution of generic SMR issues to improve the potential for commercialization, such as:**
  - User requirements for SMRs
  - Technical analyses to address licensing concerns
  - Economics
  - Market analysis

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Growing National Interest in Advanced Reactors

- **DOE supports advancing innovative reactor technologies and improving their economic competitiveness by:**
  - Conducting targeted laboratory R&D to reduce technical challenges
  - Conducting the Advanced Test/Demonstration Reactor Study to identify options to address innovation and commercialization
  - Cost-sharing the development of advanced reactor concepts
    - X-Energy (Pebble Bed High Temperature Gas Reactor) and Southern Company Services (Molten Chloride Fast Reactor) were selected to initially receive $6M each.
  - Working with the Nuclear Regulatory Commission (NRC) to reduce licensing challenges for advanced reactors
  - Facilitating industry access to DOE expertise through the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative
    - Streamlining processes
    - Voucher program

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Summary

- **Nuclear power must play a significant role in our energy future**
- **Nuclear power has many benefits that current economic conditions do not consider**
  - Diversity
  - Reliability
  - Environmental
- **The continued long-term operation of the existing fleet of nuclear power plants via SLR is a critical part of our energy infrastructure**
- **New nuclear plants needed in the long term**
  - Large PWRs
  - SMRs
  - Advanced Reactors

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